CLAIMS

1. A gait generating device having instantaneous gait generating means for sequentially generating an instantaneous desired gait composed of an instantaneous desired motion of a mobile robot and an instantaneous desired floor reaction force, comprising:

first provisional corrected motion determining means for determining a first provisional corrected instantaneous desired motion obtained by provisionally correcting the position and the posture of a predetermined part of the mobile robot from the instantaneous desired motion;

second provisional corrected motion determining means for determining a second provisional corrected instantaneous desired motion obtained by provisionally correcting the position of the predetermined part from the instantaneous desired motion while maintaining the posture of the predetermined part to be the same as the posture in the instantaneous desired motion; and

desired motion correcting means for determining a corrected instantaneous desired motion obtained by executing a true correction of the position and the posture of the predetermined part in the instantaneous desired motion on the basis of the first provisional corrected instantaneous desired motion and the second provisional corrected instantaneous desired motion,

wherein, if all or a part of the mobile robot is

expressed in terms of a model constructed of a plurality of elements, the elements being at least either rigid bodies having inertia or mass points, the placement of elements of the model determined according to a predetermined first geometric restrictive condition, which specifies the relationship between an instantaneous motion of the mobile robot and the placement of the elements of the model, from an instantaneous desired motion generated by the instantaneous gait generating means is defined as a first placement, the placement of the elements of the model determined according to a predetermined second geometric restrictive condition, which specifies an instantaneous motion of the mobile robot and the placement of the elements of the model, from the first provisional corrected instantaneous desired motion determined by the first provisional corrected motion determining means is defined as a second placement, and the placement of the elements of the model determined according to the second geometric restrictive condition from the second provisional corrected instantaneous desired motion determined by the second provisional corrected motion determining means is defined as a third placement, then

the first provisional corrected motion determining means determines the first provisional corrected instantaneous desired motion such that the translational force component of the resultant force of the inertial forces of the elements calculated by treating the

difference in the placement of the elements of the model between the second placement and the first placement as acceleration becomes substantially zero and also the moment component generated about a predetermined point by the resultant force takes substantially a predetermined value,

the second provisional corrected motion determining means determines the second provisional corrected instantaneous desired motion such that the moment component generated about the predetermined point by the resultant force of the inertial forces of the elements calculated by treating the difference in the placement of the elements of the model between the third placement and the first placement as acceleration takes substantially the predetermined value, and

the desired motion correcting means determines the sum of the result obtained by multiplying the posture of the predetermined part in the first provisional corrected instantaneous desired motion by a predetermined weight w1 and the result obtained by multiplying the posture of the predetermined part in the second provisional corrected instantaneous desired motion by a predetermined weight w2 as the instantaneous desired posture of the predetermined part in the corrected instantaneous desired motion, and also determines the sum of the result obtained by multiplying the position of the predetermined part in the first provisional corrected instantaneous desired motion

by the predetermined weight w1 and the result obtained by multiplying the position of the predetermined part in the second provisional corrected instantaneous desired motion by the predetermined weight w2 as the instantaneous desired position of the predetermined part in the corrected instantaneous desired motion.

2. A gait generating device having instantaneous gait generating means for sequentially generating an instantaneous desired gait composed of an instantaneous desired motion of a mobile robot and an instantaneous desired floor reaction force, comprising:

provisional corrected motion determining means for determining a provisional corrected instantaneous desired motion obtained by provisionally correcting the position and the posture of a predetermined part of the mobile robot from the instantaneous desired motion; and

desired motion correcting means for determining a corrected instantaneous desired motion obtained by executing a true correction of the position and the posture of the predetermined part in the instantaneous desired motion,

wherein, if all or a part of the mobile robot is expressed in terms of a model constructed of a plurality of elements, the elements being at least either rigid bodies having inertia or mass points, the placement of elements of the model determined according to a predetermined first geometric restrictive condition, which

specifies the relationship between an instantaneous motion of the mobile robot and the placement of the elements of the model, from an instantaneous desired motion generated by the instantaneous gait generating means is defined as a first placement, the placement of the elements of the model determined according to a predetermined second geometric restrictive condition, which specifies an instantaneous motion of the mobile robot and the placement of the elements of the model, from a provisional corrected instantaneous desired motion determined by the provisional corrected motion determining means is defined as a second placement, and the placement of the elements of the model determined according to the second geometric restrictive condition from the corrected instantaneous desired motion determined by the desired motion correcting means is defined as a third placement, then

the provisional corrected motion determining means determines the provisional corrected instantaneous desired motion such that the translational force component of the resultant force of the inertial forces of the elements calculated by treating the difference in the placement of the elements of the model between the second placement and the first placement as acceleration becomes substantially zero, and also the moment component generated about a predetermined point by the resultant force takes substantially a predetermined value, and

the desired motion correcting means determines the

sum of the result obtained by multiplying the posture of the predetermined part in the provisional corrected instantaneous desired motion by a predetermined weight w1 and the result obtained by multiplying the posture of the predetermined part in the instantaneous desired motion generated by the instantaneous gait generating means by a predetermined weight w2 as the instantaneous desired posture of the predetermined part in the corrected instantaneous desired motion, and also determines the instantaneous desired position of the predetermined part in the corrected instantaneous desired motion such that the moment component generated about a predetermined point by the resultant force of the inertial forces of the elements calculated by treating the difference in the placement of the elements of the model between the third placement and the first placement as acceleration takes substantially a predetermined value.

3. The gait generating device of a mobile robot according to Claim 1 or 2, comprising means for variably determining at least the predetermined weight w1 on the basis of at least the condition of a road surface on which the mobile robot is to be operated according to the desired gait or the motion mode of the mobile robot according to the desired gait, the magnitudes of both the predetermined weights w1 and w2 falling within the range of 0 to 1.

4. The gait generating device of a mobile robot

according to Claim 3, wherein the sum of the magnitude of the predetermined weight w1 and the magnitude of the predetermined weight w2 is 1.

5. The gait generating device of a mobile robot according to Claim 1 or 2, wherein the predetermined weight w1 is a weight having a frequency characteristic relative to the posture of the predetermined part multiplied by the same.

6. The gait generating device of a mobile robot according to Claim 1 or 2, wherein

in the moment component related to the difference in placement of the elements between the second placement and the first placement, the component originated from the difference between position A in the first placement and position B in the second placement of the elements of the model having masses is calculated from an angle formed by a segment connecting the predetermined point and the position A and a segment connecting the predetermined point and the position B by using a substantially monotonous function related to the angle, and

in the moment component related to the difference in placement of the elements between the third placement and the first placement, the component originated from the difference between position A in the first placement and position C in the third placement of the elements of the model having masses is calculated using the monotonous function from the angle formed by the segment connecting

the predetermined point and the position A and a segment connecting the predetermined point and the position C.

7. The gait generating device of a mobile robot according to Claim 1 or 2, wherein the instantaneous desired motion generated by the instantaneous gait generating means is determined using a dynamic model that represents the relationship between a motion of the mobile robot and a floor reaction force and that is constructed on the assumption that the inertial force generated by a specific motion component of at least one or more specific parts of the mobile robot is substantially zero, and the model includes an element corresponding to at least one part of the specific parts.

8. The gait generating device of a mobile robot according to Claim 1 or 2, wherein

an instantaneous desired motion generated by the instantaneous gait generating means is determined such that it satisfies a desired floor reaction force or a desired ZMP on a predetermined dynamic model representing a relationship between a motion of the mobile robot and a floor reaction force, and

the first and the second geometric restrictive conditions are set such that a value obtained by adding a predetermined steady offset to the difference between a floor reaction force counterbalancing with a resultant force of the inertial forces of the elements that are generated due to temporal changes in the placement of the

elements of the model determined according to the first geometric restrictive condition from the instantaneous desired motion and a floor reaction force counterbalancing with a resultant force of the inertial forces of the elements that are generated due to temporal changes in the placement of the elements of the model determined according to the second geometric restrictive condition from the instantaneous desired motion substantially agrees with an error of a floor reaction force produced in the dynamic model by the instantaneous desired motion.

9. The gait generating device of a mobile robot according to Claim 1 or 2, wherein

an instantaneous desired motion generated by the instantaneous gait generating means is determined so that a desired floor reaction force or a desired ZMP on a predetermined dynamic model representing a relationship between a motion of the mobile robot and a floor reaction force is satisfied, and

the first and the second geometric restrictive conditions are set such that a value obtained by multiplying the difference between the overall center-of-gravity of the placement of the elements of the model determined according to the first geometric restrictive condition from the instantaneous desired motion and the overall center-of-gravity of the placement of the elements of the model determined according to the second geometric restrictive condition from the instantaneous desired

motion by the total mass of the elements substantially agrees with a value obtained by multiplying an error of the overall center-of-gravity of the dynamic model in the instantaneous desired motion by a total mass of the dynamic model.

10. The gait generating device of a mobile robot according to Claim 1 or 2, wherein the mobile robot is a robot comprising a plurality of legs or a plurality of arms extended from its body as a plurality of movable members, and the first geometric restrictive condition includes a condition in which any one of the elements of the model exists on a straight line parallel to a segment connecting a predetermined point in the vicinity of a distal portion of each movable member and a predetermined point in the vicinity of the portion of the movable member that is connected to the body.

11. The gait generating device of a mobile robot according to Claim 1 or 2, wherein the mobile robot is a robot comprising a plurality of legs or a plurality of arms extended from its body as a plurality of movable members, and the first geometric restrictive condition includes a condition in which the body and the movable members on the model are retained in a predetermined constant posture state.

12. The gait generating device of a mobile robot according to Claim 11, wherein the predetermined constant posture is the posture in which the body and the plurality

of movable members of the mobile robot are oriented substantially in the vertical direction.

13. The gait generating device of a mobile robot according to Claim 1 or 2, wherein the second geometric restrictive condition is set such that the placement of the elements of the model determined according to the condition from an arbitrary instantaneous desired motion of the mobile robot substantially agrees with the placement of parts corresponding to the elements in the robot following the instantaneous desired motion.

14. The gait generating device of a mobile robot according to Claim 1 or 2, wherein the mobile robot comprises a plurality of legs or a plurality of arms extended from the body as a plurality of movable members and also has flexible joints at middle portions between the portions of the movable members that connect to the body and the distal portions of the movable members, and an instantaneous desired motion generated by the instantaneous gait generating means is determined using a dynamic model that represents a relationship between a motion of the robot and a floor reaction force and that is constructed on the assumption that the inertial forces produced at or near the middle portions of the movable members due to bending motions of the movable members are substantially zero, the model being a model that contains, as elements, mass points associated with at least middle portions or portions close thereto of the movable members.

15. The gait generating device of a mobile robot according to Claim 14, wherein the first geometric restrictive condition includes a condition in which a mass point associated with a middle portion or a portion close thereto of each movable member of the elements of the model exists on the segment that connects a predetermined point in the vicinity of the distal portion of the movable member and a predetermined point in the vicinity of the portion of the movable member that links with the body, and the second geometric restrictive condition is set such that the placement of the elements of the model determined according to the condition from an arbitrary instantaneous desired motion of the mobile robot substantially agrees with the placement of parts corresponding to the elements in the robot following the instantaneous desired motion.